FORM PTO-1390 (REV. 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY 'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	102014-102
	U S. APPLICATION NO. (If known, see 37 CFR 1 5) N/A 09/937373

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US00/07692	March 21, 2000	March 22, 1999

TITLE OF INVENTION
VACUUM SEAL

APPLICANT(S) FOR DO/EO/US
D. Gregory More and Stephen S. Stone

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [X] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
N/A 09/937373	PCT/US00/07692	102014-102

21. ☒ The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 690.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 0	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$
Total claims	13 - 20 =	0	x **$18.00**	$ 0
Independent claims	4 - 3 =	1	x **$80.00**	$ 80
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$ 0

TOTAL OF ABOVE CALCULATIONS =	$ 770.00	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +	$ 385.00	
SUBTOTAL =	$ 385.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).	$ 0	
TOTAL NATIONAL FEE =	$ 385.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +	$ 40.00	
TOTAL FEES ENCLOSED =	$ 425.00	
	Amount to be refunded:	$
	charged:	$

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 23-1665 in the amount of $ 425.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any defficiencies or additional fees which may be required, or credit any overpayment to Deposit Account No. 23-1665 . A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO: Customer Number 27267

27267
PATENT TRADEMARK OFFICE

SIGNATURE

William B. Slate
NAME

37,238
REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	D. Gregory More and Stephen S. Stone	Docket No.:	102014-102
Serial No.:	PCT US00/07692	Art Unit:	N/A
Filed:	March 21, 2000	Examiner:	N/A
Assignee:	The Advanced Products Company		
Title:	Vacuum Seal		

NATIONAL PHASE PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, DC 20231

Dear Sir:

In the matter of the above-identified application for Letters Patent, please enter and consider the following amendments and remarks:

AMENDMENT

In the Inventorship:

Please amend the inventorship from "Dominick G. More and Stephen S. Stone" to read -- D. Gregory More and Stephen S. Stone --.

In the Claims:

Please amend claims 1-13 to read as follows:

CLAIMS

We Claim:

1. (Amended) A vacuum seal for sealing a pair of opposed metal flanges, the seal comprising an outer metallic annular member having a generally c-shaped longitudinal radial cross-section and an inner metallic annular member having a generally c-shaped longitudinal radial cross-section, wherein the outer metallic annular member has a pair of oppositely-directed, longitudinally outward-projecting, ridges for deformably engaging the pair of opposed metal flanges and the inner metallic annular member has longitudinal strength and elasticity effective to maintain the ridges in engagement with the flanges.

2. (Amended) The seal of claim 1 wherein the inner metallic annular member provides the primary structural integrity of the seal.

3. (Amended) The seal of claim 1 wherein the inner metallic annular member has a characteristic thickness of between about 2 and 4 times a characteristic thickness of the outer metallic annular member.

4. (Amended) The seal of claim 1 wherein the inner metallic annular member is formed of a nickel-based superalloy and the outer metallic annular member is formed of an aluminum-based material.

5. (Amended) The seal of claim 1 wherein the each of the ridges has a longitudinal extent beyond a thickness of the outer member away from the ridges.

6. (Amended) An annular vacuum seal for sealing first and second opposed flanges to maintain an internal pressure less than an external pressure, the seal having nested inner and outer members and having a longitudinal radial section which is characterized by:

the outer member being generally c-shaped and open radially outward; and

the inner member nested within the outer member and being generally c-shaped and open radially outward and having a wall thickness effective to maintain the outer member in engagement with the first and second flanges in the absence of a spring nested within the inner member.

7. (Amended) The seal of claim 6 wherein:

the inner member has a full plating of a copper-base material.

8. (Amended) The seal of claim 6 wherein:

the inner member is formed of a nickel-base superalloy; and

the outer member is formed of an aluminum-base material.

9. (Amended) The seal of claim 6 being effective to provide a leakage rate of no more than about 4x10-12 cm3/s-mm.

10. (Amended) The seal of claim 6 wherein the inner metallic annular member longitudinal radial cross-section has a central arcuate portion and a pair of distal straight portions extending radially outward from opposite ends of the arcuate portion.

11. (Amended) A method for manufacturing an annular vacuum seal for sealing first and second opposed flanges to maintain an internal pressure less than an external pressure, the seal having nested inner and outer members:

welding ends of a piece of a first metal together to form a first band;

die-forming the first band into a generally c-shaped, open radially outward, cross-section so as to form the inner member having a wall thickness effective to resist compression of the seal between the first and second flanges so as to maintain the outer member in sealed engagement with the first and second flanges to maintain said internal pressure;

inserting a second band of a second metal within the first band;

forming the second band into a c-shaped cross-section around the inner member; and

roll-forming first and second opposed, longitudinally outward projecting, annular ridges in the second band to provide the outer member.

12. (Amended) The method of claim 11 wherein:

the inner member is plated prior to insertion of the second band; and

the ridges are flat lapped.

13. (Amended) An annular vacuum seal for sealing first and second opposed flanges to maintain an internal pressure less than an external pressure, the seal having nested inner and outer members and having a longitudinal radial section which is consists essentially of:

the outer member being generally c-shaped and open radially outward;

the inner member nested within the outer member and being generally c-shaped and open radially outward and having a wall thickness effective to maintain the outer member in engagement with the first and second flanges; and

optionally one or more coating or plating layers.

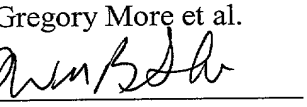
REMARKS

In the present Application, claims 1-13 are pending and at issue. By this Amendment, claims 1-13 have been amended, no claims have been canceled, and no claims have been added. Accordingly, claims 1-13 are presented and at issue. By this Amendment, claims 1-13 are believed to be in condition for allowance.

By the foregoing amendment, multiple dependencies are removed from the claims as are reference numerals. Additionally, first-named inventor Dominick Gregory More has requested that the present application identify him as "D. Gregory More" rather than "Dominick G. More."

Please apply any credits or charge any fees or deficiencies to our Deposit Account No. 23-1665.

Respectfully submitted,
D. Gregory More et al.



William B. Slate
Reg. No. 37,238

Date: 9/20/01

Wiggin & Dana
One Century Tower
P.O. Box 1832
New Haven, CT 06508-1832
(203) 498-4400
(203) 782-2889 Fax

CLAIMS

We Claim:

1. (Amended) A vacuum seal [(20; 120)] for sealing a pair of opposed metal flanges [(110A, 100B)], the seal [(20; 120)] comprising an outer metallic annular member [(24; 124)] having a generally c-shaped longitudinal radial cross-section and an inner metallic annular member [(22; 122)]having a generally c-shaped longitudinal radial cross-section, wherein the outer metallic annular member [(24; 124)] has a pair of oppositely-directed, longitudinally outward-projecting, ridges [(40A,40B)] for deformably engaging the pair of opposed metal flanges [(100A,100B)] and the inner metallic annular member has longitudinal strength and elasticity effective to maintain the ridges [(40A,40B)] in engagement with the flanges.

2. (Amended) The seal of claim 1 wherein the inner metallic annular member [(22; 122)] provides the primary structural integrity of the seal.

3. (Amended) The seal of claim 1 wherein the inner metallic annular member [(22; 122)] has a characteristic thickness of between about 2 and 4 times a characteristic thickness of the outer metallic annular member [(24; 124)].

4. (Amended) The seal of claim 1 [any of claims 1-3] wherein the inner metallic annular member [(22; 122)] is formed of a nickel-based superalloy and the outer metallic annular member [(24; 124)] is formed of an aluminum-based material.

5. (Amended) The seal of claim 1 [any of claims 1-3] wherein the each of the ridges has a longitudinal extent [(L_3)] beyond a thickness of the outer member away from the ridges.

6. (Amended) An annular vacuum seal [(20; 120)] for sealing first and second opposed flanges [(100A,100B)] to maintain an internal pressure less than an external pressure, the seal [(20)] having nested inner [(22; 122)] and outer [(24; 124)] members and having a longitudinal radial section which is characterized by:

the outer member [(24; 124)] being generally c-shaped and open radially outward; and

the inner member [(22; 122)] nested within the outer member [(24)] and being generally c-shaped and open radially outward and having a wall thickness effective to maintain the outer member in engagement with the first and second flanges in the absence of a spring nested within the inner member.

7. (Amended) The seal of claim 6 wherein:

the inner member [(22; 122)] has a full plating of a copper-base material.

8. (Amended) The seal of claim 6 wherein:

the inner member [(22; 122)] is formed of a nickel-base superalloy; and

the outer member [(24; 124)] is formed of an aluminum-base material.

9. (Amended) The seal of claim 6 [any of claims 6-8] being effective to provide a leakage rate of no more than about $4x10^{-12}$ cm^3/s-mm.

10. (Amended) The seal of claim 6 [any of claims 1-3, 6-8] wherein the inner metallic annular member [(122)] longitudinal radial cross-section has a central arcuate portion [(150)] and a pair of distal straight portions [(150A, 150B)] extending radially outward from opposite ends of the arcuate portion.

11. (Amended) A method for manufacturing an annular vacuum seal [(20; 120)] for sealing first and second opposed flanges [(100A, 100B)] to maintain an internal pressure less than an external pressure, the seal having nested inner [(22; 122)] and outer [(24; 124)] members:

welding ends of a piece of a first metal together to form a first band;

die-forming the first band into a generally c-shaped, open radially outward, cross-section so as to form the inner member [(22; 122)] having a wall thickness effective to resist compression of the seal between the first [(100A)] and second [(100B)] flanges so as to maintain the outer member [(24; 124)] in sealed engagement with the first [(100A)] and second [(100B)] flanges to maintain said internal pressure;

inserting a second band of a second metal within the first band;

forming the second band into a c-shaped cross-section around the inner member [(22; 122)]; and

roll-forming first and second opposed, longitudinally outward projecting, annular ridges in the second band to provide the outer member [(24; 124)].

12. (Amended) The method of claim 11 wherein:

the inner member is plated prior to insertion of the second band; and

the ridges are flat lapped.

13. (Amended) An annular vacuum seal [(20; 120)] for sealing first and second opposed flanges [(100A,100B)] to maintain an internal pressure less than an external pressure, the seal [(20)] having nested inner [(22; 122)] and outer [(24; 124)] members and having a longitudinal radial section which is consists essentially of:

the outer member [(24; 124)] being generally c-shaped and open radially outward;

the inner member [(22; 122)] nested within the outer member [(24)] and being generally c-shaped and open radially outward and having a wall thickness effective to maintain the outer member in engagement with the first and second flanges; and

optionally one or more coating or plating layers.

VACUUM SEAL

This application claims the benefit of U.S. Patent Application 60/125,493, filed March 22, 1999 and entitled "Vacuum Seal", the disclosure of which is incorporated by reference in its entirety herein.

This invention relates to seals, and more particularly to metallic vacuum seals.

A variety of vacuum seal configurations exist. Vacuum seals are commonly held under compression between two opposed flanges of the elements being sealed to each other. Vacuum seals may be used in a variety of industrial applications including semiconductor fabrication and processing.

One basic vacuum seal is formed substantially as a large flat washer of a soft, malleable, metal such as copper. An example of this seal is sold by Varian Vacuum Products Lexington of Lexington, Massachusetts, USA under the trademark CONFLAT. Such a seal may be used with flanges having an annular machined knife edge. When the seal is compressed between the flanges, the knife edges embed into the seal to provide the sealing. The flanges must be hard and strong enough to withstand the necessary compression force. This type of seal has little tolerance for relative motion of the flanges.

Another class of metallic vacuum seals is the so-called c-seal. This is an annular seal of generally c-shaped cross-section which can compress between the flanges to be sealed. An advanced version of the c-seal is sold by EG&G Pressure Science, Inc. of Beltsville, Maryland, USA under the trademark ALPHA. The ALPHA seal utilizes a relatively stiff core member plated with relatively malleable silver to provide improved sealing with the flanges. A somewhat similar seal is disclosed in U.S. Pat. No. 4,261,584.

An enhanced metal seal is sold by Helicoflex of Columbia, South Carolina, USA under the trademark HELICOFLEX DELTA. A similar seal is disclosed in U.S. Pat. No. 4,561,662. The DELTA seal has two metallic jackets surrounding a tightly wound helical spring which provides the seal with longitudinal elasticity. The inner jacket, or lining, may be formed of stainless steel or a superalloy. The outer jacket is made of a more ductile material such as aluminum and has a pair of machined delta-sectioned knife edges for engaging the respective flanges. When the seal is compressed between the flanges, the delta edges are crushed to seal against the flanges.

In one aspect, the invention is directed to an annular metallic vacuum seal having a nested inner and outer c-sectioned members. The inner member provides longitudinal compression strength and elasticity and the outer member has a pair of oppositely-directed ridges for sealing with a pair of flanges.

One of the advantages of the invention is that the seal is relatively easy to clean, particularly for those surfaces on the low pressure side of the seal. The presence of crevices or other hard to clean areas on the vacuum side may be minimized.

The longitudinal elastic compliance provided by the inner member and the longitudinal plastic compliance provided by the outer member may combine to provide an excellent seal between mating flanges at relatively low compressive forces which reduces the need to make the flanges out of ultra high strength material and of robust dimensions while also reducing the number of bolts needed to maintain compression between the flanges. Preferred leakage rates are less than $8x10^{-13}$ cm^3/s-mm under standard conditions utilizing a helium mass spectrometer to monitor leakage.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

FIG. 1 is a top plan view of a seal according to principles of the invention.

FIG. 2 is a cross-sectional view of the seal of FIG. 1, taken along line 2-2.

FIG. 3 is a cross-sectional view of the seal of FIG. 2, shown compressed between mating flanges.

FIG. 4 is a top view of an alternate seal according to principles of the invention.

FIG. 5 is a cross-sectional view of the seal of FIG. 4, taken along line 5-5.

Like reference numbers and designations in the various drawings indicate like elements.

FIG. 1 shows a vacuum seal 20 for maintaining a seal between first and second opposed flanges (not shown) to maintain an internal pressure less than an external pressure. The seal is of generally annular configuration, being angularly symmetric about a central longitudinal axis 500. When viewed in longitudinal radial section (*i.e.*, along a central longitudinal plane 501 outward from the axis 500) the seal is generally c-shaped and open radially outward (FIG. 2).

The seal is substantially symmetric about a transverse centerplane 502. The seal has nested inner and outer members or jackets 22 and 24, respectively. Both are generally c-shaped and open radially outward. The inner member has inner and outer surfaces 26 and 28 joined by edge surfaces 30A and 30B. The outer member has inner and outer surfaces 32 and 34, respectively. In FIG. 2, a line 503 (a cylindrical construct when not viewed in cross-section) designates the radial location of the maximum longitudinal span of the inner member 22. Proximate the annular ends of the outer member 24, the outer member includes longitudinally-projecting protuberances 40A and 40B which provide annular ridges. These protuberances project slightly beyond the adjacent portions of the outer surface 34. The longitudinal extremities 42A and 42B of the ridges 40A and 40B engage the adjacent flanges 100A and 100B (FIG. 3) to form a seal and may be exactly or nearly coaligned with the line 503. The outer member 24 need not extend substantially radially beyond the line 503. Viewed relative to the intersection of the line 503 and plane 502, this may be from a few degrees to about 20 degrees beyond the line 503. The inner member advantageously extends slightly farther therebeyond, e.g., to an exemplary 30° beyond the line 503. The inner member 22 provides the primary structural integrity of the seal and is formed of a material and with dimensions effective to maintain compressive engagement with the flanges. This will be achieved by making the inner member substantially thicker than the outer member. A preferred material for the inner member is sold by INCO Alloys International, Inc. under the trademark INCONEL Alloy 718. Other "superalloys" having a nickel base and significant amounts of iron and chromium (for corrosion resistance) may also provide advantageous performance. High strength, high gall-resistance stainless steels such as that sold under trademark ULTIMET by Haynes International, Inc. of Kokomo, IN may also be used. A preferred material for the outer jacket is aluminum 1100 (99.0% Al minimum), a substantially pure aluminum. Various aluminum alloys may also be utilized as can other ductile metals.

In an exemplary nominal three inch (7.62 cm) diameter seal (measured as a minimum diameter D_1 of the longitudinal opening within the outer member 24 at the plane 502) the inner member may have a relaxed longitudinal length L_2 of about 0.16 inches (0.41 cm) and a thickness of about 0.024 inches (0.061 cm). A broader thickness range is 0.015-0.035 inches (0.038-0.089 cm). The ridges may have a longitudinal extent L_3 of about 0.005 inch (0.013 cm). A thickness of the outer member (away from the ridges) may be about 0.01 inches (0.025 cm), a thickness well under half the exemplary thickness of the inner member. A broader thickness range is 0.005-0.020 inches (0.0123-0.051 cm). The radial extent or span S_1 of the

outer member may be about 0.10 inches (0.25 cm). The ridge extremities 42A and 42B form a pair of flat annuli with a radial span S_3 of about 0.006 inches (0.015 cm). The longitudinal span L_1 of the outer member at the line 503 between the extremities 42A and 42B may be an exemplary 0.19 inch (0.48 cm). When compressed between opposed flat annular surfaces 102A and 102B of flanges 100A and 100B, the ridges are both plastically and elastically deformed to form a seal and the inner member is plastically and elastically longitudinally compressed (e.g., by about 0.044 inch (0.11 cm) so that compressed overall and inner member lengths L_1' and L_2' are about 0.16 inch (0.41 cm) and 0.14 inch (0.36 cm) to bias the ridges into engagement with the flanges. An exemplary compressive engagement force on the seal is 400-1000 lbs/inch (7-17.5 N/m) of contact length (seal circumference at the ridges).

An exemplary process for production of the seal is as follows. Strip stock of the material for the inner member is cut to correct length and width. The ends of the strip stock are welded together to form a hoop or band. The band is then roll formed to circularize it. It is then die formed to produce the basic c-shaped section. It is then heat treated to increase strength. It is then cleaned and electroplated with copper or other decorative/appearance enhancing-material. Alternatively, instead of plating, the jacket may be electropolished.

To prepare the outer jacket, aluminum is advantageously cold drawn to provide a long tubular body which is then cut longitudinally to form bands. This avoids the difficulties of welding aluminum. Alternatively, the band may be formed by welding ends of a strip (e.g., by laser, tungsten inert gas (TIG), electron beam (EB), and the like). One such band is then placed radially within the inner jacket and roll formed to wrap it into the c-shaped section around the inner jacket. Then, a second roll step forms the ridges. The seal is then flat lapped to provide the ridges with the desired degree of parallelism, planarity, surface uniformity, and longitudinal separation. Finally, the seal is cleaned and packaged in contamination-resistant packaging.

FIGS. 4 and 5 show an alternate embodiment of a seal 120 having nested inner and outer members 122 and 124, respectively. The outer member 124 may be substantially identical to the outer member 24 and its portions are not, therefore, referenced with distinct numerals. The inner member 122 has inner and outer surfaces 126 and 128 adjoined by edge surfaces 130A and 130B. The inner member 122 is formed having a central arcuate portion 150 and a pair of distal straight portions 150A and 150B extending from opposite ends of the arcuate portion. The distal portions are oriented substantially parallel to each other directed radically outward so as to provide a pair spaced-apart flat flanges. The distal portions extend beyond the line 503 by a distance which is a significant fraction of the total radial span of the

inner member. An exemplary distance would be between about a third and a half of this span. Preferred dimensions of an alternate embodiment of the alternate size of the exemplary seal 120 are D_1=40.579 inches (103.07 cm); S_0=0.177 inch (0.45 cm); S_1=0.117 inch (0.30 cm); L_1=0.241+/-0.010 inch (0.612+/-0.025 cm); L_2=0.194+/-0.004 inch (0.493+/-0.010 cm); L_3=0.009-0.014 inch (0.23-0.36 cm). The inboard transition between the ridges and the adjacent outer surface of the outer member is radiused to about 0.01 inch (0.025 cm) and the outboard radial ridges are chamfered to an angle of about 45 degrees by 0.005 inch (0.013 cm). The inner jacket is formed from strip stock 0.0300+/-0.0010 inch (0.0762+/-0.0025 cm) thick and 0.405+/-0.003 inch (1.029+/-0.008 cm) wide. The outer member is formed from strip stock 0.0120+/-0.0005 inch (0.0305+/-0.0013 cm) thick and 0.402+/-0.002 inch (1.021+/-0.001 cm) wide. For such a seal, compressed overall and inner member lengths L_1' and L_2' would be about 0.197-0.199 inch (0.500-0.505 cm) and 0.173-0.175 inch (0.439-0.445 cm).

One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, various dimensions and properties may be chosen to adapt to a particular environment and may be selected to form the seal as a drop-in replacement for existing seals. Accordingly, other embodiments are within the scope of the following claims.

Unless noted otherwise, wherever both English and metric units are given for a physical value, the English units shall be assumed to be the original measurement and the metric units a conversion therefrom.

PCT/US 00/07692
IPEA/US 28 JUL 2001

CLAIMS

1. A vacuum seal (20; 120) for sealing a pair of opposed metal flanges (110A, 100B), the seal (20; 120) comprising an outer metallic annular member (24; 124) having a generally c-shaped longitudinal radial cross-section and an inner metallic annular member (22; 122) having a generally c-shaped longitudinal radial cross-section, wherein the outer metallic annular member (24; 124) has a pair of oppositely-directed, longitudinally outward-projecting, ridges (40A,40B) for deformably engaging the pair of opposed metal flanges (100A,100B) and the inner metallic annular member has longitudinal strength and elasticity effective to maintain the ridges (40A,40B) in engagement with the flanges.

2. The seal of claim 1 wherein the inner metallic annular member (22; 122) provides the primary structural integrity of the seal.

3. The seal of claim 1 wherein the inner metallic annular member (22; 122) has a characteristic thickness of between about 2 and 4 times a characteristic thickness of the outer metallic annular member (24; 124).

4. The seal of any of claims 1-3 wherein the inner metallic annular member (22; 122) is formed of a nickel-based superalloy and the outer metallic annular member (24; 124) is formed of an aluminum-based material.

5. The seal of any of claims 1-3 wherein the each of the ridges has a longitudinal extent (L_3) beyond a thickness of the outer member away from the ridges.

6. An annular vacuum seal (20; 120) for sealing first and second opposed flanges (100A,100B) to maintain an internal pressure less than an external pressure, the seal (20) having nested inner (22; 122) and outer (24; 124) members and having a longitudinal radial section which is characterized by:

the outer member (24; 124) being generally c-shaped and open radially outward; and

the inner member (22; 122) nested within the outer member (24) and being generally c-shaped and open radially outward and having a wall thickness effective to maintain the outer

PCT/US 00/07692
IPEA/US 28 JUL 2001

member in engagement with the first and second flanges in the absence of a spring nested within the inner member.

7. The seal of claim 6 wherein:
the inner member (22; 122) has a full plating of a copper-base material.

8. The seal of claim 6 wherein:
the inner member (22; 122) is formed of a nickel-base superalloy; and
the outer member (24; 124) is formed of an aluminum-base material.

9. The seal of any of claims 6-8 being effective to provide a leakage rate of no more than about $4x10^{-12}$ cm^3/s-mm.

10. The seal of any of claims 1-3, 6-8 wherein the inner metallic annular member (122) longitudinal radial cross-section has a central arcuate portion (150) and a pair of distal straight portions (150A, 150B) extending radially outward from opposite ends of the arcuate portion.

11. A method for manufacturing an annular vacuum seal (20; 120) for sealing first and second opposed flanges (100A, 100B) to maintain an internal pressure less than an external pressure, the seal having nested inner (22; 122) and outer (24; 124) members:
welding ends of a piece of a first metal together to form a first band;
die-forming the first band into a generally c-shaped, open radially outward, cross-section so as to form the inner member (22; 122) having a wall thickness effective to resist compression of the seal between the first (100A) and second (100B) flanges so as to maintain the outer member (24; 124) in sealed engagement with the first (100A) and second (100B) flanges to maintain said internal pressure;
inserting a second band of a second metal within the first band;
forming the second band into a c-shaped cross-section around the inner member (22; 122); and
roll-forming first and second opposed, longitudinally outward projecting, annular ridges in the second band to provide the outer member (24; 124).

12. The method of claim 11 wherein:

PCT/US 00/07692
IPEA/US 28 JUL 2001

the inner member is plated prior to insertion of the second band; and

the ridges are flat lapped.

13. An annular vacuum seal (20; 120) for sealing first and second opposed flanges (100A,100B) to maintain an internal pressure less than an external pressure, the seal (20) having nested inner (22; 122) and outer (24; 124) members and having a longitudinal radial section which is consists essentially of:

the outer member (24; 124) being generally c-shaped and open radially outward;

the inner member (22; 122) nested within the outer member (24) and being generally c-shaped and open radially outward and having a wall thickness effective to maintain the outer member in engagement with the first and second flanges; and

optionally one or more coating or plating layers.

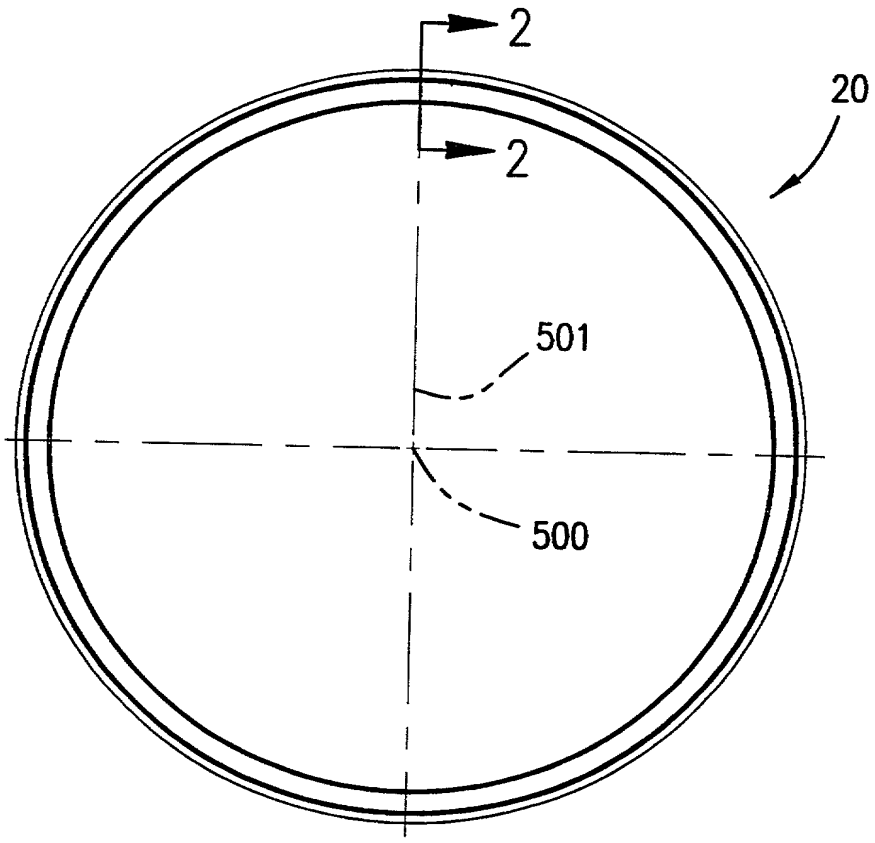


FIG. 1

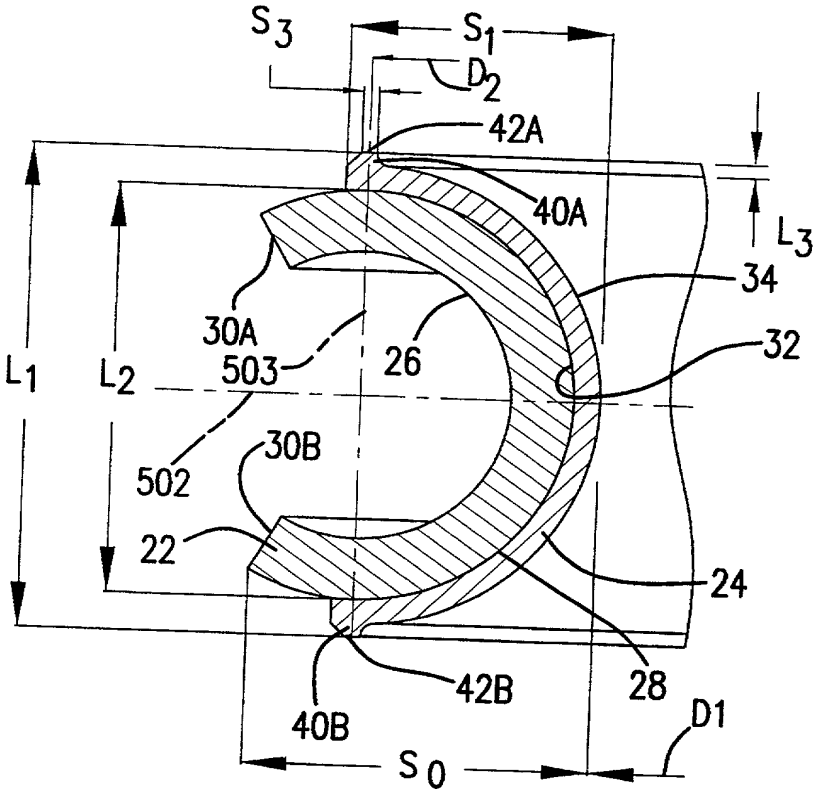

S3
S1
D2
42A
40A
L3
34
30A
503
26
32
L1
L2
502
30B
22
24
42B
28
40B
D1
S0

FIG.2

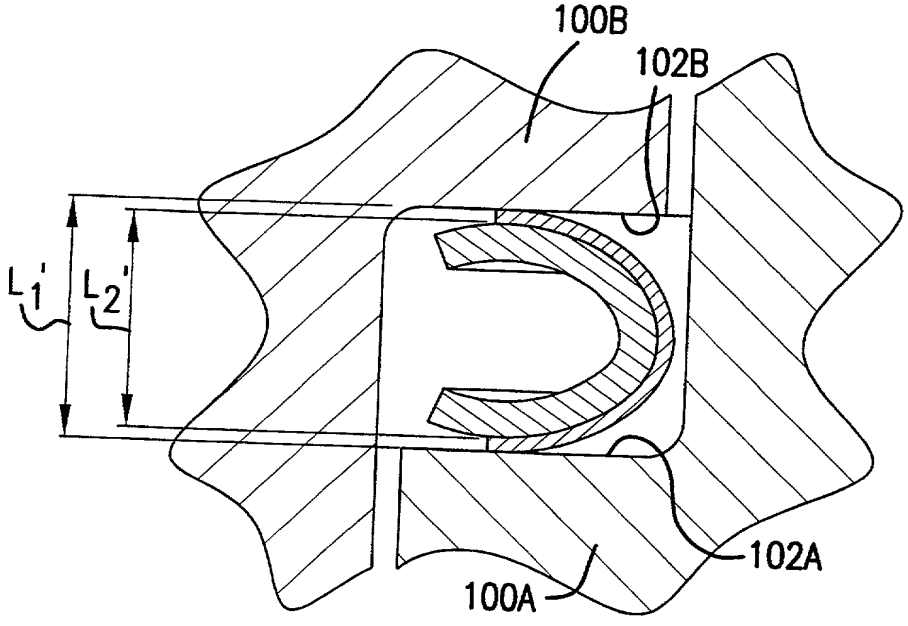

100B
102B
L1'
L2'
102A
100A

FIG.3

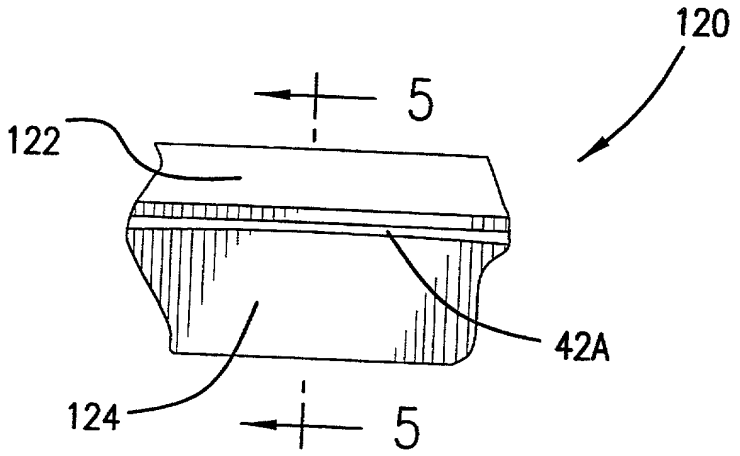

120
5
122
42A
124
5

FIG.4

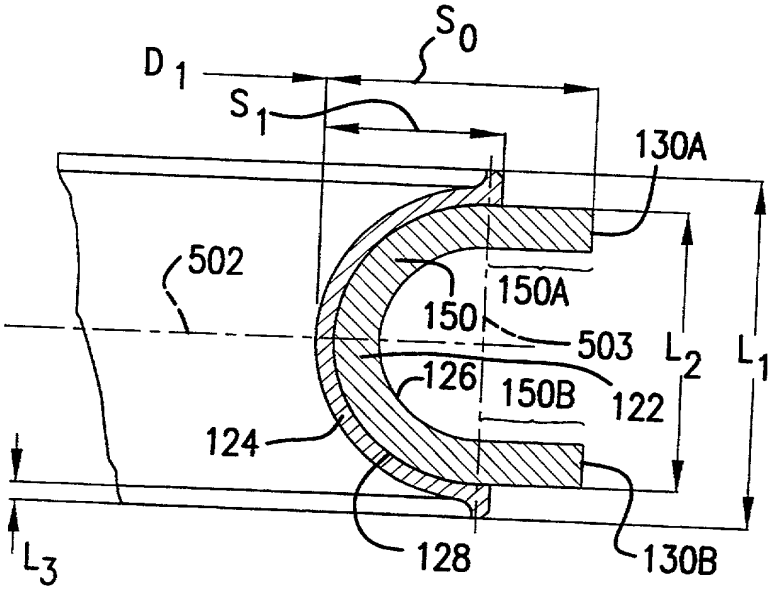

S_0
D_1
S_1
130A
502
150
150A
503
L_2
L_1
126
150B
122
124
L_3
128
130B

FIG.5

Please type a plus sign (+) inside this box → [+]

PTO/SB/01 (12-97)
Approved for use through 9/30/00. OMB 0651-0032
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☒ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	102014-102
First Named Inventor	Dominick G. More
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

VACUUM SEAL

(Title of the Invention)

the specification of which
☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY) 03/21/2000 as ~~United States Application Number or~~ PCT International Application Number PCT/US00/07692 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)
60/125,493	03/22/1999

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Please type a plus sign (+) inside this box → [+]

PTO/SB/01 (12-97)
Approved for use through 9/30/00. OMB 0651-0032
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number [ ] → Place Customer Number Bar Code Label here
OR
☒ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
William B. Slate	37,238	Gregory S. Rosenblatt	32,489
Dale L. Carlson	28,784	William A. Simons	27,096
Jody L. DeStefanis	44,653	William J. Speranza	26,340
Todd E. Garabedian	39,197		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number or Bar Code Label [ ] OR ☒ Correspondence address below

Name	William B. Slate				
Address	Wiggin & Dana				
Address	P.O. Box 1832				
City	New Haven	State	CT	ZIP	06508-1832
Country	US	Telephone	203-498-4400	Fax	203-782-2889

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Dominick G.	More

Inventor's Signature	[signature]					Date	6/7/00
Residence: City	Middletown	State	CT	Country	US	Citizenship	US
Post Office Address	43 Horseshoe Lane						
Post Office Address							
City	Middletown	State	CT	ZIP	06457	Country	US

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

Please type a plus sign (+) inside this box → [+]

PTO/SB/02A (3-97)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor
Given Name (first and middle [if any])	Family Name or Surname
Stephen S.	Stone

Inventor's Signature						**Date**	6/7/00
Residence: City	North Haven	**State**	CT	**Country**	US	**Citizenship**	US
Post Office Address	100 State Street, Apt. #20						
Post Office Address							
City	North Haven	**State**	CT	**ZIP**	06473	**Country**	US

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor
Given Name (first and middle [if any])	Family Name or Surname

Inventor's Signature						**Date**	
Residence: City		**State**		**Country**		**Citizenship**	
Post Office Address							
Post Office Address							
City		**State**		**ZIP**		**Country**	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor
Given Name (first and middle [if any])	Family Name or Surname

Inventor's Signature						**Date**	
Residence: City		**State**		**Country**		**Citizenship**	
Post Office Address							
Post Office Address							
City		**State**		**ZIP**		**Country**	

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.